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THE MUSEUM OF THINGS VERSUS THE MUSEUM OF IDEAS[1]

By Dr. WILLIAM K. GREGORY

AMERICAN MUSEUM OF NATURAL HISTORY

THERE was once a museum man named G. Browne Goode, who said in effect that a museum should be an exhibit of ideas, set forth by labels and illustrated by well-chosen specimens; but this prophet of a better day has been dead a long time and museums of natural history have been very slow to give his principle a fair trial.

History repeats itself. In the eighteenth century, when the young science of zoology was just beginning to get on its feet, there were two schools of zoologists: the first, reacting against the zoologic myths and fables of the Middle Ages, professed itself as the humble recorder of facts and is therefore referred to as the School of Facts (*L'Ecole des Faits*). A work entitled *"Memoires pour servir a l'Histoire Naturelle des Animaux,"* published at the Hague in 1731, was especially noteworthy because it illustrated the status and ideals of natural history in France during the reign of Louis XV. It records the results of a series of dissections performed upon animals from the Jardin du Roi, by a committee of the Royal Academy of Sciences. The work is animated by the spirit of the *"école des faits"* and illustrates both the search for absolute certainty and the reaction against all theory and generalization—tendencies which were characteristic of the science of the period. The authors remind us that natural history had long been burdened with error and overgrown with fanciful speculation. They had proposed to themselves the task of accumulating a body of anatomical facts, each of which was to be

[1] Address before the Academy of Natural Sciences of Philadelphia, May 25, 1936.

attested and authenticated by the whole committee. Each detail of their figures likewise was to be attested, after having been drawn by one of their own members, by a hand guided by science as well as by art. And they "will not," for example, "affirm aught of Bears in general" but will say only that "a Bear which we have dissected had this particular conformation." They profess to hope that upon such a foundation of concrete facts some Aristotle of the future may build a secure philosophy, a veracious natural history.

Adherents of the School of Facts are apt to be rather superior in their dealings with their opponents, the advocates of the School of Ideas. And it must be confessed that they frequently know a great deal more about their subject than their opponents do. The great Cuvier, for example, who was the leader of the School of Facts in the late eighteenth and early nineteenth centuries, had no difficulty in citing facts which easily refuted the ingenious idea of Geoffroy Saint Hilaire that a vertebrate animal was merely a highly disguised insect swimming on its back! And later on, the "Circularians" and the "Trinitarians" of the School of Ideas were only too ready to tell what the Creator had in his mind when, as they vainly imagined, he created series of forms in circles or triangles. It was on the whole a healthy reaction against moonshine in zoology which led to the almost complete triumph of the School of Facts.

This triumph, however, entailed its penalties. For example, the ideal of human anatomy became the compilation of many hundreds of pages of descriptive detail, at first without a single clue from either embryology or comparative anatomy. In anthropology the passion for facts led to the amassing of millions of measurements—most of which were eventually condemned as inexact by anthropological popes of later times. In paleontology the Particularists, or modern successors of the School of Facts, love caution almost as much as acquisition. Industrious as ants and productive as bees, they demand more and more carloads of facts before attempting the elaboration of any ideas. They are willing indeed to declare a long moratorium upon theories, which are often produced by stay-at-home drones.

In many branches of zoology Theodore Gill's dictum that "analysis must precede synthesis" has had curious results. Species were broken up into smaller units, the old species were promoted to be genera, the genera became subfamilies, the subfamilies attained the rank of families, families were stepped up into suborders, suborders into orders, and so on. And when the uncivilized tribes of the Myxomycetes or slime fungi were formally annexed to the kingdom of animals, only a taxonomic dictator was lacking to promote said kingdom into an empire.

Another curious result of the labors of the industrious School of Facts is that the supreme fact of evolution is constantly being overlooked just because the myopic workers can see only the smaller bits of it which they have hacked off from the vast tree of life.

Meanwhile, the doctrine of polyphyly, or the coexistence of numerous independent lines of descent from some very ancient common ancestor, has seemed to some investigators to have transformed the old-fashioned or branching family tree into an indefinite number of nearly parallel lines fading off into the bottomless abyss of geologic time. In short, analysis has so far outrun synthesis that in some cases we might almost as well adopt an alphabetical arrangement of animals as a substitute for a real classification based on natural relationships. Thus the Particularists are largely to blame for the existence of the odious but well-turned phrase that a natural scientist is a man who knows more and more about less and less. Of course he might retort that some folks know less and less about more and more.

Some of the greatest museums in the world include tens of thousands of square feet of exhibition space. Even if there is an average of only one named thing in each square foot, how soon will the visitor be lost in the wilderness of things with names! All those who know their Robert Louis Stevenson will recall his quaint verse:

> This world is so full of a number of Things,
> I'm sure we should all be as happy as Kings.

The visitor to many of the old-fashioned museums of natural history, after wandering through hall after hall full of stuffed animals, of dusty birds mounted on little wooden stands and thousands of insects stuck on pins, might well be tempted to paraphrase Stevenson and say wearily:

> This Museum is so full of so many Things,
> I feel as depressed as a bird with clipped Wings.

As long as an exhibition hall is conceived to be primarily a dictionary for reference, the curators will naturally try to make it as complete as possible and will not only exclude everything not directly pertaining to the dictionary function but will cram their shelves to the limit of capacity. Under such circumstances the poor wight, or average visitor, soon becomes "fed up," as he phrases it, and only pauses a few seconds here and there as one does when idly turning over the pages of Webster's Unabridged. The experimental psychologists, however, with stop-watches in hand, have proved that there is just one thing, in even the worst hall, which will almost invariably quicken the tired visitor's pace when first he catches a distant glimpse of it. That thing is the exit!

There are other aspects of exhibition in which the old-fashioned Museum of Things was palpably defi-

cient. Take, for example, the matter of human interest. In a certain museum there is a huge canoe hollowed out of a gigantic tree by the Haida Indians of the Northwest coast. The canoe contains a number of human figures, some of them wearing masks and evidently dressed in ceremonial costumes. The label with this exhibit notes that the people in the canoe are conducting a potlatch, or ceremonial visit, including the chief and his party, to the people of another village. But the human values, the motivation of the event, are not referred to. Why is the chief making this visit? Is it only a decent exchange of civilities? No; it is his supreme opportunity to vaunt himself, to cover his rival, the other chief, with shame and confusion. How will he do it? He will start with fair speech and compliments. Then, warming up to his work, he will begin making presents, one after another, until it hurts both the giver and the recipient.

"Here are a baker's dozen of these beautifully decorated boxes, piled higher, chief, than your house! Here are these superb woollen blankets, far better than any *you* have ever slept under. Here is this magnificent porcupine quill work! You know you can't equal it. Here's a perfectly sound slave.—Stand up, wretch, and show yourself! We'll use him as a target in this afternoon's sports! [Great applause.] But here's the supreme gift—my No. 1 wife! (Now top that, you miserable insect!)"

Meanwhile please try to imagine the secret feelings of the poor village taxpayers on both sides when they realize next day that they and they alone will have to pay for all this extravagance!

The old-fashioned museum was of course by no means the only educational institution in which human values and interest were studiously ignored. As a freshman student of zoology in a well-known college, I could not for a long time see much use in the endless array of anatomical terms which the student was expected to attach to the drawings of his dissections. "What," I asked my instructor at last, "is the use of all this?" But he, being one of the recent initiates, smiled in a superior way and replied: "Mr. Gregory, that is a question we never ask in zoology." I knew there must be something wrong with the answer, but it took me some years to find out what it was. One fault was that the element of human interest was at a minimum just so long as each unknown part of an earthworm's anatomy had an equally unknown name attached to it. What indeed *was* the use of learning to associate two sets of apparently useless things?

I might have been told that the study of the anatomy of the earthworm was useful because it would help me later to understand human anatomy; or I might have been shown the earthworm as a wonderful living mechanism which conducts its boring operations with an efficiency that might well shame a modern engineer; or why did not my instructor read to us Darwin's fascinating account of the work of the earthworm in preparing the soil for the farmer? But there was only the smelly earthworm, half ruined in my dissecting pan, with little blobs of messy parts and long names to be attached to them! Is it any wonder that the School of Things in zoology nearly drove me into the ministry?

So too in paleontology I was early told by a museum curator that the famous fossil skeleton of *Phenacodus primaevus* Cope was worth more than all the theories that would ever be based upon it. Again I knew that there was something wrong with the answer, but what was it? I should say now that the value of any museum specimen is only a potential or estimated value so long as no human being gets any scientific ideas from it. The specimen begins to function as an object of science only when and in so far as it serves as a basis of scientific knowledge.

But not even in museums of natural history have the Particularists succeeded in burying every idea under a thick deposit of minute details. The Generalizers have always insisted that the aim of science is not only to collect, catalogue, identify and exhibit things, but to find out and to expose, so far as humanly possible, why things are as they are and according to what rules events are shaped. The Generalizers have also clung to the opinion that even an imperfect and temporary explanation or hypothesis is much better than none at all, provided, however, that it be clearly recognized as a stage in the development of men's ideas as to the causes of things.

However, nothing is simple (at least in museums) and there are perhaps as many difficulties as there are things. For hundreds of millions of years nature has been turning out new things, new situations, merely by combining old elements in different proportions at different times. Also, since new events and things are seldom if ever the products of single causes, each simple thing to-day has lines of antecedent causes and conditions which spread out in a network of infinite extent and age. In other words, since there have been myriads of individual factors that have contributed to even the simplest events of to-day, the world itself would not be big enough to hold the books that might be written thereon, nor the earth wide enough for an adequate exhibit thereof.

But because explanations may not be final and complete, must the visitor be left to bump around aimlessly and without clue or guidance until, wearied by contact with unmeaning objects and long words, he quickens only at the sight of the exit?

Department stores, movie directors and the Sunday papers often show a great deal more about the art of exhibition than do many old-fashioned museums.

For one thing, the window-dressers in the better department stores long since discovered the fundamental importance of unity, emphasis and coherence, and they have also hit upon the high value of the rest, or interval of empty space, for the bewildered eye.

Ineffective public instruction is exemplified when great crowds of people merely drift by an exhibit and never think of it again. Effective public instruction is achieved when people stop, look, read, mark, learn and inwardly digest, the exhibit, so that it adds permanently to their stock of useful knowledge. But in order to maintain public instruction in a state of vitality there must be a constant stream of new discoveries, new scientific material, new exhibits, and there must be a perfect cooperation between the producers of scientific values and the teachers thereof.

Fortunately the trustees and staff of the Academy of Natural Sciences of Philadelphia some years ago discovered that something very radical must be done to an old-fashioned museum in order to preserve and harmonize its functions as a treasury of scientific material and as a center of research, with its function as an active teacher of scientific principles. Already great progress has been made, as any one can see by visiting the beautiful galleries of mammals, or the striking individual exhibits already installed in the hall of geology and minerals. Moreover, the academy has never failed to realize that its primary function is that of an active research and publication center, so that even in the worst days of the depression it continued to publish the results of investigations by the preeminent scientists who are the real fount of its power and prestige.

The plans set forth in the brochure entitled *"Frontiers"* would, if means could be found to carry them out, place the Academy of Natural Sciences of Philadelphia in the forefront of those institutions which are opening up and exploring the vast fields of science and education. The academy can be enabled to carry out this splendid program of public instruction in the principles of science only if the citizens of Philadelphia realize its great value to them and help to bear the cost of transforming a Museum of Things into a Museum of Ideas.

THE PHYSICIAN AS ANTHROPOLOGIST

By Professor T. WINGATE TODD

WESTERN RESERVE UNIVERSITY AND BRUSH FOUNDATION

THE sudden and untimely death of my distinguished colleague, Dr. Roger Griswold Perkins, floods my mind with memories of significant accomplishments and fills my heart with gratefulness for creative insight and the enthusiastic promotion of an ideal which bids fair ultimately to rank among the most practical of dreams which ever took shape within the fertile brain of man.

To the American familiarized even to the point of commonplace with the rapid growth of cities those basically constructive measures which make congested areas fit for habitation are too often taken for granted. But to one like myself, born and bred in the Old World, the miracle of health in such a neighborhood must always stand as the most striking of the gifts to mankind by men whose ambition is fulfilled in service without the mead of praise. Here was the man who took the typhoid out of Cleveland water; built up the city's division of health; insisted on the proper inspection of food; the man behind the Cleveland Health Council. Yet on his retirement this metropolitan area of three million souls, each one of whom owes to Dr. Perkins security of health, could let him slip quietly away without a word of acknowledgment to his homestead in Rhode Island, so sated are our people with service and security.

This present testimony, however, draws attention to a still more fundamental contribution to human welfare than making life safe for a legion of fellowmen. It happened that, by the inscrutable working of destiny I, who had found my greatest thrill, under the guidance of Sir Grafton Elliot Smith, in delving into the mortality statistics of the ancient Egyptians, while this was still possible pending completion of the Assouan Dam, was thrown into professional association with Dr. Perkins, who, like myself, had been too busy with the daily round to formulate the principle which was the mainspring of endeavor. It was obvious, however, from these studies on the imperishable remains of an early people that no adequate time-table of the impact of life upon humanity could be constructed except in a center where official enlightenment makes possible the serial study of human beings in life and death. Cleveland was the one community where this was possible and Perkins the one man who could make that study effective. His accession, in 1911, to the chair of hygiene and preventive medicine the year before my arrival and his growing prestige in municipal and county management made possible the study which we both had planned. His guidance and diplomatic tact made possible the substitution of a Permanent Morgue for the Potter's Field, and that permanent morgue to-day comprises 3,000 of our fellow townsmen, most of whom, recruited from our local hospitals, brought with them the essential records for analysis

of that human biology without which the skeleton and brain are no more than the sealed casket of the lost secrets of life. The influence of the late dean of medicine, Dr. C. A. Hamann, ensured university approval and support. And thus developed the greatest research collection of documented human and anthropoid skeletons available for study to-day.

Many industrious workers from this continent, Europe and the far East have demonstrated that the material records housed in the Hamann Museum are but the end results of the human growth pattern warped, interrupted or inhibited by those disabilities which, in their varying intensity, scar the human frame. For though the internal organs recover their functional integrity it is the framework of the body which bears the scars of misadventure.

By 1924 it was apparent that the impassable barrier encountered by physical anthropology is this unsolved problem of the growth pattern and its vicissitudes. Sheering off from this closed approach physical anthropology has spent its energy in an attack upon race for the practical consideration of which one anthropologist alone, Dr. Franz Boas, has clearly seen the clue. Race has been magnified through national prejudice and this one voice calls us to clear thinking on the tangle of human relationships. Any local race or type living in cultural or social isolation among the surrounding population will inevitably persist as an unassimilated minority. But in so far as cultural or social barriers are removed, that local race must inevitably merge with the surrounding population and eventually become indistinguishable in culture, customs and psychological reactions, maintaining only those hereditary characteristics inherent in the family strain.

The institution in 1925 of the Cleveland Health Council gave Dr. Perkins his chance, and he took the second step in the synthesis of which I write. This required the serial observation of growing children, while those influences which modify and twist the growth pattern are still in active operation. It meant the breaking down of traditional barriers in medical study and resulted in the Anatomical Laboratory being transformed from a charnel house into a well-children's clinic. Through the active help of the Cleveland Board of Education this was done and the first financial aid was secured for the purpose by the Health Council itself. Slowly there emerged the evidence that the living child is a very different individual from the dead. Hitherto all our known records of developmental growth had been obtained from the bodies of dead children, retarded and contorted in their growth patterns by the slow insidious poison of disease. But now, in contrast, the patterns of the living children revealed fulfilment of latent potentialities, both structural and functional, denied to those who had fallen before the onslaught of disaster. This theme became the topic of the White House Conference: it finds expression in the volumes published under the leadership of Dr. Kenneth D. Blackfan and is reflected in the Children's Charter.

It was this theme, so amply demonstrated by the comparison of records on the living and the dead which gave Dr. Perkins his crowning inspiration. By the accident of fate he had become the son-in-law of the late Dr. Charles Francis Brush, the inventor of the arc lamp and the storage battery. It was Dr. Brush's ambition to see mankind helped toward a fuller realization of potentialities, since in man himself, not his environment, lies the secret of adjustment and content. Dr. Perkins, aided by his indefatigable wife and staunch friends, showed Dr. Brush that the surest way to this goal was by a long and toilsome route, the safeguarding of the well-born child. Thus the Brush Foundation came into active operation in 1929. Its object is to explore and define the latent potentialities of humanity with the aim of ultimately attaining their fulfilment. This movement, started in Cleveland, has developed to large proportions in the past seven years. Dr. Brush clearly saw that his foundation, generous as it was, could never accomplish unaided the program which Dr. Perkins spread before him. It must be seconded by other farseeing philanthropic efforts. Cleveland has been quick to realize human welfare in the broadest sense. The passing years have seen this movement grow. In 1930 Charles Bingham Bolton and his mother, Mrs. Chester C. Bolton, set up the fund which bears their name, so that, under my able colleague, Dr. B. Holly Broadbent, there might be provided, in facial and dental developmental growth, the counterpart of Dr. Brush's study of bodily developmental pattern. In 1930 national funds extended the study to a record of the developing mind. In 1933 began the Edna Perkins study of adolescent girls for the purpose of mitigating if possible the ravages of tuberculosis. In 1934 the Cleveland Foundation took up the investigation of constitution as part of its Coulby Fund endeavor on behalf of sick, needy and crippled children. In 1934 also the Richman Fund for the study of personality was established by Mr. Charles Richman, whose recent death cut off one whose sympathies recognized neither race nor creed but not before the leaven of his humanity had permeated this grateful city. In 1935 the Allergy Foundation joined the group to provide a clinical background for the Cleveland Foundation study.

The result of these united efforts is the Developmental Health Inquiry of the Associated Foundations. In the program serial longitudinal studies are made of growing children accepted originally by lustra of five

years to ensure inclusion of all stages in development from conception to parenthood. Preconceptional parents, expectant mothers, children at every age level are methodically studied from the point of view of constitutional fitness and developmental health. It is not a clinical examination but one of human biology in which, however, physician-in-charge as well as parents and educators join with the foundations, each participator supplying his special information to the common stock. Studies are made of progress, not of status, and cover the following themes: Growth increments and proportions, physical maturity progress, weight gain and analysis, dento-facial development, brain potentials and muscle action currents, mental expansion, psychomotor development, hand-eye coordination, motor development, skills, steadiness, dexterity, emotional stability, intellectual and social adjustment, interests and talents, personality ratings, vocational leanings and choices. It is obviously as nearly complete a study of the preparation of human beings for entry into full citizenship as a practical scheme will permit. It is, moreover, facilitated by the essential services of instrument-making, chart-making, statistics, photography and motion picture studies, the resources of the Hamann Museum, of the experimental laboratory for constitutional chemistry and of the animal farm maintained by the Anatomical Department and its Associated Foundations.

Here, then, is the answer to the appeal made by my brilliant and vigorous colleague, Dr. E. A. Hooton, in the pages of SCIENCE for March 20, 1936; an answer originating indeed in the casual scratchings of medical leisure but now a truly cooperative effort covering the disciplines pertaining to body, mind and constitution; an answer in which medical science, far from myopic, works forward from the cradle, not backward from the morgue, except in so far as death is but the stepping-stone to a larger more abundant life; an answer for which we are indebted in its inception to the man who took the typhoid out of Cleveland water.

SCIENTIFIC EVENTS

THE BRITISH INSTITUTE OF PHYSICS

Nature reports that the annual general meeting of the Institute of Physics was held on May 19. After election of the officers and completion of the panel of the board, it was announced that the following would take office on October 1, 1936: *President,* Professor A. Fowler; *Vice-president,* F. Twyman; *Honorary Treasurer,* Major C. E. S. Phillips; *Honorary Secretary,* Professor J. A. Crowther; *New Members of the Board,* Colonel K. W. E. Edgcumbe and Professor R. Whiddington.

The annual report for the year 1935 which was adopted at the meeting shows that membership has continued to increase and that the high standard required for corporate membership has been maintained. The total membership at the end of the year was 822.

The first Industrial Physics Conference to be held in Great Britain took place in Manchester in March, 1935, and the attendance was nearly 550. The subject of the conference was "Vacuum Devices in Research and Industry" and an exhibition of instruments, apparatus and books cognate to the subject was arranged and was open to the public. Some 3,500 people visited the exhibition.

A Midland Local Section was inaugurated in November, the towns covered being Birmingham, Leicester, Nottingham and Rugby.

The report shows that the scheme for the training and certificating of laboratory assistants has developed satisfactorily and 21 certificates were issued during the year. The institute's services in placing employers in touch with physicists seeking permanent posts and with consultants were in constant demand throughout the year. The circulation of the *Journal of Scientific Instruments* increased during the year, both on account of the commencement of its distribution to "associates" without extra payment and on account of sales to non-members.

THE BRITISH INSTITUTE FOR THE STUDY OF ANIMAL BEHAVIOR

THE British Institute for the Study of Animal Behavior has been formed by a number of zoologists, naturalists, physiologists and psychologists with the object of promoting and encouraging research into animal behavior. The institute intends to act as a clearing-house for information regarding work that is being done upon animal behavior in all its aspects and to bring together for the discussion of their problems field and laboratory workers. It is hoped to issue to members a quarterly bulletin in which will be provided summaries of and references to the chief work being done in the various branches of the subject. Meetings for the transactions of scientific business will be held at intervals.

The institute hopes eventually to obtain the means of supporting research and, possibly, of maintaining its own research station.

Those whose work is concerned with animal behavior will materially assist the task of the institute if they will send offprints of their papers to the Honorable Secretary, R. C. Oldfield, The Psychological Laboratory, Cambridge.

Officers of the society have been elected as follows:

President, Julian S. Huxley.
Treasurer, F. B. Kirkman.
Honorary Secretary, R. C. Oldfield.
Council, J. C. Flügel, G. C. Grindley, C. F. A. Pantin, E. S. Russell, B. P. Wiesner and S. Zuckerman.

THE LIBRARY AND LABORATORY OF THE LATE SAMUEL COX HOOKER

PRESIDENT ROBERT H. RUFF, of Central College, Fayette, Missouri, announces that through the assistance of Wm. R. Warner and Company, of New York and St. Louis, Central College has just acquired the entire scientific library of the late Samuel C. Hooker, Ph.D.

Dr. Hooker's children, Mrs. Douglas Treat Davidson, Mrs. Sidney W. Davidson and Samuel Cox Hooker, Jr., have presented to Central College their father's private research laboratory, which was located with the library at his residence, 82 Remsen Street, Brooklyn, New York, including the supplies and equipment and their father's study. The library, laboratory and study are now being packed under the direction of Dr. Neil E. Gordon for removal to Central College, where the library will be installed and the laboratory reconstructed on the campus of the college in order to duplicate so far as possible the original arrangements.

President Ruff writes:

> Dr. Hooker's death on October 12, 1935, removed from the ranks of American chemists one of its most remarkable figures. He was a former director and one of the chief technicians of the American Sugar Refining Company and was largely responsible for the development of the beet sugar industry in the United States. He organized the technical operation of all the company's beet sugar factories west of the Mississippi River and retired in 1916 at the age of fifty-six to devote himself to research in organic chemistry and the enjoyment of one of his principal recreations, the collection of scientific books. He continued his research and the building up of his scientific library until the time of his death. His library is recognized as one of the most complete and comprehensive scientific libraries in the world. It was catalogued after Dr. Hooker's death under the supervision of William W. Shirley, of the Pratt Institute Free Library of Brooklyn. It consists largely of scientific journals and includes many sets of obscure periodicals. In addition to chemistry other fields represented are sugar technology, pharmacology, metallurgy, dyes, physics and botany. The periodicals consist of over 18,000 volumes in addition to over 2,400 books and pamphlets.
>
> Among other extraordinary items is a complete set of the Philosophical Transactions of the Royal Society of London from the commencement in 1665. This is the oldest scientific periodical in the world which is still being published. The earlier volumes include the bookplate of Richard Arkwright, the inventor of the spinning jenny. The library includes many volumes which were at one time owned by the late Sir William Crookes. Early American titles include the *American Journal of Science* from 1818 and the *Journal of the Franklin Institute* from 1826. Dr. Hooker assembled the library from many sources both in this country and abroad and the periodicals are written not only in English but in many foreign languages, including Italian, Swedish, Dutch, Polish, French, German, Danish, Magyar and Japanese.
>
> In his boyhood Dr. Hooker was interested in photography, and his library includes some of the earliest volumes on that subject, dating as far back as 1855 and a treatise on color photography published in 1878.
>
> Dr. Gordon, who is now professor of chemistry at the Johns Hopkins University, will assume his duties as chairman of the chemistry department at Central College at the beginning of the next college year. The acquisition of Dr. Hooker's scientific library and laboratory will afford Central College the opportunity of developing scientific work of the first order.

FIELD CONFERENCE OF PENNSYLVANIA AND NEW YORK GEOLOGISTS

A LARGE and representative group took part in the field conference of Pennsylvania and New York Geologists held in the anthracite region of Pennsylvania from May 22 to 24, 1936. The registrants, 99 in number, came from thirty-three institutions and organizations in New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, Delaware and Washington, D. C.

The conference assembled in Scranton, spending the first afternoon in visiting the Marvine Breaker, the Grassy Island Mine and the Baltimore Fire Stripping of the Hudson Coal Company and the Archbald Pothole. Remarkably fine fossil plants were seen at Grassy Island and numerous fossil stumps at Baltimore Fire Stripping. Mr. R. Y. Williams, of Pottsville, gave a brief history of the anthracite industry at the evening meeting in Wilkes-Barre.

Saturday was spent in a traverse of the different anthracite fields to show the structures, stripping operations, "bootleg" coal mines, the extent of the workings and the problems involved in obtaining the coal. The St. Nicholas Breaker of the Philadelphia and Reading Coal and Iron Company was visited on this day.

Saturday night a moving picture entitled "Stolen Coal," dealing with the "bootleg" coal industry, was shown by the Stevens Coal Company, and one entitled "Buried Sunshine" on the mining and preparation of coal by the Pennsylvania and Reading Coal and Iron Company.

Sunday the party studied the Mauch Chunk-Pottsville contact south of Tamaqua and then proceeded to Lansford for a trip underground in the Coaldale Colliery of the Lehigh Navigation Coal Company. The

Summit Hill fire barrier and stripping was the last coal property visited, after which the party went to the carnotite locality in the Pottsville conglomerate near Mauch Chunk, at which point they disbanded.

The trip was planned and conducted by the staff of the department of geology, Lehigh University, with the hearty assistance and cooperation of various coal companies.

LAWRENCE WHITCOMB,
Secretary

IN HONOR OF PROFESSOR CARLSON

ON June 1 a portrait bust of Dr. Anton J. Carlson, prepared by Mrs. Alice Littig Siems, was presented to the University of Chicago by students, colleagues and friends of Dr. Carlson. The unveiling and presentation speech was made by Dr. A. B. Luckhardt, who paid the following tribute to his colleague:

It is unfortunate, perhaps, that I, who probably know Professor Anton Julius Carlson better than any one in this audience, should have been called upon to present to the University of Chicago, through its vice-president, this portrait bust about to be unveiled. I think I know enough of medical history, with its lore and legends, to thoroughly realize that many of the past worthies have been glorified much beyond their merited deserts. I do not propose to make the same mistake by a deluge of encomiums and reflection on *a great man* and *one* with a marvelous career. Even if he were here with us, I should say the same of him. He would not want it otherwise from me.

Many years ago, Anton Julius Carlson came from Sweden as a lad of fourteen—a non-descript immigrant. America gave him an opportunity for a fruitful life of scientific and civil endeavor and influence. He seized the opportunity and made the most of it. First at Stanford University, next at Pennsylvania and then at Chicago, he pursued biological truths on the basis of intense experimental efforts. Throughout a long life time, he has practiced the principle that facts must be ascertained by observation and not by divination. After that, logic and philosophy might well toy with them. Like his illustrious predecessors, he used a variety of gadgets to get at the facts; and like a Claude Bernard and a Carl Ludwig he wove a logical and philosophical fabric about many of them. But, he would be the first to discount the importance of the philosophic fabric, and also the first to emphasize the importance of the facts.

Establishing for himself an enviable record at this university as a great teacher and investigator, he attracted numerous students. Many a recipient of a higher degree from this university (and one well earned under Dr. Carlson's guidance) now holds an important post in this country. In fact, I doubt whether any departmental chairman at this university or abroad, past or present, could adduce a greater scientific progeny than he—with the possible exception of the immortal Carl Ludwig!

Aside from a warped judgment on the scientific worth of former students and adventurers in science, born of extreme personal loyalty, he has distinguished himself among his medical and scientific colleagues by an unerring judgment based on astute and critical analysis of the presented data. That is why potential contributors to scientific and medical journals have sought his counsel in advance, to avoid his straight-from-the-shoulder and trenchant criticism on the floor of any scientific gathering.

Little wonder then that scientific bodies of all kinds have elected him to work in their behalf and have granted him honors. He is on all occasions an honored, respected and inspiring guest. His admirers here and abroad are legion!

I have the honor and the rare privilege to present to you, Mr. Woodward, as representative of the university, the portrait bust of Professor Anton Julius Carlson, living and active chairman of the department of physiology.

Vice-president Woodward, in receiving the gift on behalf of the university, also paid tribute to Dr. Carlson's accomplishments and expressed, on behalf of the president and board of trustees, their great appreciation of his long service to the university.

RECENT DEATHS

DR. JOHN H. HAMMOND, consulting mining engineer, died on June 8 at the age of eighty-one years.

DR. JULIUS A. NIEUWLAND, professor of chemistry at Notre Dame University, died suddenly on June 11. He was fifty-eight years old.

DR. CHARLES E. JOHNSON, head of the department of forest zoology and director of the Roosevelt Wild Life Forest Experiment Station at the New York State College of Forestry, died on June 6, at the age of fifty-six years.

DR. ALBERT B. REAGAN, special professor of anthropology at Brigham Young University, died on May 30 at the age of sixty-five years. Before joining the staff of Brigham Young University in 1934 he had served for thirty-four years in the U. S. Indian Service.

THURAL DALE FOSTER, a promising young student of Mollusca, died of Hodgkin's disease on June 6 after having completed all requirements for the doctorate in zoology in the University of Illinois. He would have received his degree on June 8.

SCIENTIFIC NOTES AND NEWS

THE honorary degree of doctor of laws, the only honorary degree given at the commencement of the Johns Hopkins University, was conferred on Dr. Joseph Sweetman Ames, president emeritus. The degree was conferred *in absentia*, owing to the illness of Dr. Ames.

AMONG degrees to be conferred by the University of Wisconsin on June 22 are the degree of doctor of science on Dr. Joseph Erlanger, professor of physiology at the Medical School of Washington University, St. Louis, and on Dr. Lewis R. Jones, professor of plant pathology at the university. The degree of doctor of laws will be conferred on Dr. Isaiah Bowman, president of the Johns Hopkins University.

WILLIAM AND MARY COLLEGE conferred at its commencement exercises on June 8 the doctorate of laws on Dr. James B. Conant, president of Harvard University.

DR. WILLIAM J. MAYO and Dr. Charles Horace Mayo received the honorary doctorate of laws at the graduation exercises of Notre Dame University. Dr. William Mayo delivered the commencement address.

THE honorary doctorate of science was conferred by Yale University on June 17 on Dr. Theophilus Shickel Painter, professor of zoology in the University of Texas, and the degree of master of science was conferred on Dr. Richard Edwin Shope, of the Rockefeller Institute for Medical Research, Princeton, N. J.

AT the commencement of the University of Pittsburgh on June 10 the degree of doctor of laws was conferred on Dr. Robert E. Doherty, dean of the School of Engineering of Yale University, president-elect of the Carnegie Institute of Technology, and the degree of doctor of science on Dr. Karl S. Lashley, professor of psychology at Harvard University.

DR. HARVEY NATHANIEL DAVIS, president of the Stevens Institute of Technology, received the honorary degree of doctor of engineering at the commencement exercises of New York University.

THE honorary degree of doctor of engineering was conferred on Dr. Harrison E. Howe, editor of *Industrial and Engineering Chemistry,* at the commencement exercises at the Rose Polytechnic Institute on June 6, when he gave the address. His subject was "Responsibilities of Technology."

H. C. MANN, senior materials engineer, Ordnance Department of the U. S. Government, Watertown Arsenal, has been awarded the Charles B. Dudley medal of the American Society for Testing Materials for 1936, for his work on "The Relation Between the Tension Static and Dynamic Tests." The medal is awarded to the author of the paper presented at the preceding annual meeting "which is of outstanding merit and constitutes an original contribution on research in engineering materials." The medal will be presented during the 1936 annual meeting at Atlantic City on July 1.

NOMINATIONS for officers of the American Society for Testing Materials for 1936–1937 are as follows: *President,* A. C. Fieldner, chief engineer, Experiment Stations Divisions, U. S. Bureau of Mines, Washington, D. C.; *Vice-president,* T. G. Delbridge, manager, Research and Development Department, The Atlantic Refining Company, Philadelphia, Pa.; *Members of Executive Committee,* O. U. Cook, assistant manager, Department of Metallurgy, Inspection and Research, Tennessee Coal, Iron and Railroad Company, Birmingham, Ala.; H. F. Gonnerman, manager, Research Laboratory, Portland Cement Association, Chicago, Ill.; C. S. Reeve, manager, research development, The Barrett Company, Leonia, N. J.; F. E. Richart, research professor of engineering materials, University of Illinois; F. M. Waring, engineer of tests, the Pennsylvania Railroad Company, Altoona, Pa.

AT the election of officers of the American Association of Cereal Chemists, Harry Liggett, Colorado Mill and Elevator Company, Denver, Colo., was elected *president;* Dr. C. H. Bailey, of the University of Minnesota, *vice-president;* Dr. D. A. Coleman, Washington, D. C., *editor-in-chief of Cereal Chemistry;* C. C. Fifield, Washington, D. C., *managing editor of Cereal Chemistry;* H. W. Putnam, Igleheart Brothers, Evansville, Ind., *secretary;* M. D. Mize, Wallace and Tiernan, Inc., Newark, N. J., *treasurer.*

PROFESSOR WILLIAM BENJAMIN FITE, since 1910 professor of mathematics, now executive head of the department at Columbia University, has been appointed Davies professor of mathematics. This chair has been newly established and is named in honor of Charles Davies, professor at the university from 1857 to 1865.

PROFESSOR DINSMORE ALTER has resigned from the University of Kansas, after a year's leave of absence, to become director of the Griffith Observatory at Los Angeles. He will be succeeded at the University of Kansas by Dr. Norman Wyman Storer, who has been appointed assistant professor of astronomy.

IN the department of physics of Cornell University, G. E. Grantham and L. P. Smith, assistant professors, have been appointed to full professorships, and M. S. Livingston, instructor, has been promoted to an assistant professorship.

FREDERICK TOM BROOKS, fellow of Emmanuel College, has been elected to the professorship of botany at the University of Cambridge as from October 1. Mr. Brooks, who will succeed Dr. A. C. Seward, master of Downing College, has been university reader in mycology since 1932.

DR. A. H. REGINALD BULLER, first professor of botany at the University of Manitoba, has resigned the

chair which he has held for thirty-two years and has been appointed professor emeritus. He proposes to continue his botanical studies in England, and his headquarters will be at the Herbarium of the Royal Botanic Gardens, Kew, Surrey.

DR. DANIEL FRANCIS CALHANE, professor of industrial and applied electro-chemistry at Worcester Polytechnic Institute, is retiring after a service of thirty-three years.

JOHN E. SNOW, professor of electric power production at the Armour Institute of Technology, will retire from teaching this year with the title of emeritus. He has been a member of the faculty since 1894, and this spring passed the retiring age of seventy years.

DR. W. V. LAMBERT, of the department of genetics at the Iowa State College, has been placed in charge of research in animal breeding in the bureau of animal industry of the U. S. Department of Agriculture at Washington, D. C. Dr. W. M. Dawson, assistant in animal husbandry at the University of Illinois, has been appointed associate animal husbandman. He will work chiefly at the National Agricultural Research Center, Beltsville, Md., on means of measuring inheritance of desirable qualities in meat animals.

PROFESSOR H. R. TOLLEY, director of the Giannini Foundation of the University of California, has been designated acting administrator of the Agricultural Adjustment Administration of the U. S. Department of Agriculture, during the extended absence of Chester C. Davis, who is making a survey of economic conditions and policies of European countries as they affect the demand for American farm products.

DR. J. R. PARKER, senior entomologist of the U. S. Department of Agriculture, with headquarters at Montana State College, has returned from Cairo, Egypt, where he represented the United States at the fourth International Locust Conference, which was attended by entomologists from twenty-six countries.

AT the twelfth conference of the International Chemical Union, to be held in Switzerland in August, Dr. Colin G. Fink will be the American guest speaker. The topic of his address will be "The Electrochemical Protection of Iron and Steel against Corrosion."

DR. F. RASETTI, professor of physics at the University of Rome and since last fall research associate in physics at Columbia University, has been appointed visiting lecturer in physics at Cornell University for the 1936 summer session. Dr. Rasetti will give a course of lectures on "The Elementary Constituents of Matter and Radiation" and will conduct a seminar on "Nuclear Physics."

DR. THOMAS T. READ, head of the School of Mines of Columbia University, will sail for China on July 28 to continue, during his sabbatical leave, his researches into the development of iron casting in China.

A SERIES of special lectures and conferences on genetics will be held at Iowa State College, Ames, Iowa, on July 9, 10 and 11. Guest speakers will be Dr. R. A. Fisher, of the Galton Laboratory of University College, London, Dr. Sewall Wright, of the University of Chicago, and Dr. L. J. Stadler, of the University of Missouri. Topics to receive special attention are the nature and rates of mutation, the genetic nature and analysis of variability in natural populations, and certain aspects of dominance and other types of non-additive gene interactions.

A SYMPOSIUM on nuclear physics will be held in the Rockefeller Physical Laboratory of Cornell University, Ithaca, N. Y., on July 2, 3 and 4. Arrangements have been made for housing those in attendance, including families, in one of the university dormitories. Those taking part in the formal program are: K. T. Bainbridge, Harvard University; M. S. Livingston, Cornell University; H. R. Crane, University of Michigan; J. J. Livingood, University of California; H. A. Bethe, Cornell University; G. Breit, University of Wisconsin; F. Rasetti, University of Rome and Columbia University; T. W. Bonner, California Institute of Technology; L. R. Hafstad, Carnegie Institution, Washington. Further information can be obtained from Professor R. C. Gibbs, Rockefeller Hall, Ithaca, N. Y.

A NEW Division of Research Associates has been established at the Battelle Memorial Institute at Columbus, Ohio, to supplement the work in fundamental science of the regular technical staff, its object being to offer intensive training in practical research to younger workers in selected branches of chemistry, metallurgy, fuels and ceramics. Appointments as research associate will be made for one year's duration and may be extended for a second year. A research associate will be expected to devote his entire time to a research problem approved by the director and supervised by members of the staff. Appointments are open to graduates of any accredited university or college, but preference will be shown to men who have demonstrated a marked aptitude for scientific research in their industrial experience or through one or more year's graduate study. The appointment will carry an annual salary of from $1,200 to $1,800 depending on the training and experience of the individual. Four appointments will be made for the year 1936–1937.

ANNOUNCEMENT of the twelfth annual session of the Science Summer Camp of the University of Wyoming

has been issued in an illustrated bulletin. Courses are offered in botany, geology and zoology. The professorial staff this year includes a representative from Columbia University; Dr. I. H. Blake, of the University of Nebraska; Dr. George D. Fuller, of the University of Chicago, and five men from the University of Wyoming—Drs. S. H. Knight, director, Aven Nelson, R. H. Beckwith, W. G. Solheim and H. D. Thomas. The camp is situated in the heart of the Medicine Bow National Forest, at an altitude of 9,500 feet. The buildings consist of a lounge-room, dining room and kitchen, lecture rooms, laboratories and furnished cabins for faculty and students. The *Camp Bulletin* may be had upon request, from Dean C. R. Maxwell, director of the summer school of the university.

THE new pharmacy building of Howard College, at Birmingham, Ala., has been completed and is ready for occupancy. It is three stories high and houses the student laboratories of pharmacology, pharmacognosy, manufacturing and dispensing pharmacy. The medical, dental and pharmaceutical alumni of the institution contributed the funds which made this development possible.

AT a meeting of the directors of the American Chemical Society, in Kansas City, a report by the business manager was submitted showing decided progress in 1936: the election of 1,671 new members for 1936 as of April 10; a paid membership in excess of 16,500 as of April 10 and a total membership, paid and unpaid, of 18,127 as of that date; a distinct increase in the receipts for membership dues and subscriptions, and an increase of approximately 20 per cent. in advertising pages in *Industrial and Engineering Chemistry* for 1936 over the same date in 1935.

A SENATE bill providing for the construction of a vessel for research work on Pacific Ocean fisheries has been vetoed by President Roosevelt with a statement that it called for "a wholly unnecessary expense." The measure would have authorized the Department of Commerce to have the vessel built for $500,000. "The Bureau of Fisheries," the President is reported to have said, "can take some out-of-date naval or coastguard ship, . . . fit her out at very low cost and maintain her usefully for many years to come."

THE United States Geological Survey announces the publication of Bulletin 865, "The Geology of the Monument Valley-Navajo Mountain Region," which presents geologic and topographic maps, cross sections, diagrams, half-tone illustrations and text descriptive of an area south of the San Juan River in southernmost Utah that includes within its limits the Rainbow Natural Bridge, Navajo Mountain, Monument Valley and ruins of the habitations of prehistoric cliff-dwelling tribes of the region. The mapping was done on a scale of 1 mile to the inch with plane table and telescopic alidade and thus affords reliable geographic information for a considerable area of which previously only exploratory maps had been available. Of more strictly technical interest to geologists are the data contained in the report on the folding of the rocks, the oil and gas possibilities of the region, and the hypothesis of the doming of the strata about Navaho Mountain by a deeply buried laccolithic intrusion.

Nature states that at the annual meeting of the Parliamentary Science Committee held at the House of Commons under the presidency of Sir Arnold Wilson on December 5, the following officers were elected: *President,* The Right Hon. the Earl of Dudley; *Chairman,* Sir Arnold Wilson, M.P.; *Vice-Chairman,* Professor B. W. Holman; *Deputy-Chairman,* Alan E. L. Chorlton, M.P.; *Hon. Secretary and Treasurer,* H. W. J. Stone. The honorary secretary's annual report discloses that during the 1934–35 session, questions were asked in Parliament concerning agricultural and horticultural research, water supplies, the International Locust Conference, milk pasteurization, aeronautical engines, the gas grid scheme, the possibility of constructing earthquake-proof buildings in India, the research powers of the agricultural marketing boards, technical education and grants for industrial and agricultural research. Members of the committee took an active part in the debates on the Herring Industry Bill and the Metropolitan Water Board General Powers Bill. Looking to the future, the committee contemplates consideration in the near future among other things of such widely diverse subjects as the endowment of research, the finance of industrial research, income tax exemption on industrial research, patent legislation reform and the remission of death duties on bequests for research.

DISCUSSION

FURTHER EVIDENCE FOR A LUNAR EFFECT ON THE IONOSPHERE FROM RADIO MEASUREMENTS

THE possibility of the occurrence of lunar tides in the ionosphere has been discussed in connection with earlier reports of a correlation between field intensity measurements and the hour angle and declination of the moon.[1] To minimize the difficulty of a possible confusion between the lunar period and the period of solar rotation of 27.3 days, measurements have been made of field intensities from distant broadcasting

[1] *Transactions of the American Geophysical Union,* National Research Council, 1932, 1933; *Terrestrial Magnetism and Atmospheric Electricity,* June, 1934.

stations covering periods of 6 to 9 hours' duration nightly. In this way there are large changes in the lunar hour angle for each night's observation, while solar activity remains practically constant during this interval. Furthermore, the results of measurements here presented were made during the last sun-spot minimum when the sun-spot numbers were near the zero value. It is thus believed that the effect of solar rotation in the present results has been for the most part eliminated.

A curve plotted with radio intensities in microvolts against lunar hour angle indicates that for the transmission between WBBM Chicago and Delaware, Ohio, there is a marked increase in field intensity strengths with the hour angle 95°. Similar reductions of measurements between KFI Los Angeles and Delaware, Ohio, reveal a pronounced maximum of field intensities at hour angle of the moon 150°. The amplitude of the intensity range is surprisingly large. Since these measurements are based on a period of low solar activity and include observations extending over large ranges of hour angle of the moon, it would appear that we have confirming evidence for some sort of a lunar tide in the ionosphere for which no adequate explanation can yet be given.

Through the courtesy of Professor H. R. Mimno data gathered at the Cruft Laboratory during 1933–1934 have become available for testing any lunar effects on the percentage of E-layer reflections based on a frequency of 3492.5 kc. About 10,000 hours of observations were included in the material. During this time there were reflections from the E-layer on approximately 250 days during the period. There was an increase in the percentage of time of reflection from the E-layer of from 12 per cent., when the moon and the sun were in close proximity, to about 22 per cent., when the differences in hour angle between the sun and the moon was 15 hours. Assuming that part of this effect may be seasonal, the difference in the observed percentages from the expected percentages based on Professor Mimno's trend curve reveals a nearly 8 per cent. increase in reflections from the E-layer as the difference between the hour angle of the sun and moon increases from 0 hours to 14 hours. Corresponding decrease in the percentage of reflections accompanies the change in hour angle difference from 14 hours to 24 hours. These results may, therefore, be interpreted as indicating that when the moon is opposite the sun there is a tendency for an increase in the ionic density on the night half of the earth's atmosphere, thus favoring increased numbers of reflections from the E-layer. When the moon is in proximity to the sun such a slight effect as it may have is probably lost in the solar effect on the day half of the earth's atmosphere.

The apparent and very appreciable change in the percentage of reflections of the E-layer with the changing position of the moon appears to add corroborating evidence for electronic tides in the atmosphere which are in agreement with deductions based on the measurements of field intensities already mentioned.

There has long been known a change in the magnetic characteristics of the earth's field which correlates with the lunar hour angle and declination. Since variations in the induced magnetism within the earth would follow changes in the electron density of the upper atmosphere, the lunar period in magnetic variation appears to give independent evidence for the existence of tides in the ionosphere.

Acknowledgment is again made of aid received from the Rumford Fund of the American Academy of Arts and Science used in acquiring the recording equipment, and also to grants from the American Association for the Advancement of Science and the American Philosophical Society for aid in pursuit of investigation of cosmic-terrestrial relationships of which the present investigation forms a part. A more complete publication and discussion of these results will appear elsewhere at a later date.

HARLAN T. STETSON

HARVARD UNIVERSITY

THE "BROWN" SNOWFALL IN NEW HAMPSHIRE AND VERMONT

THE Bureau of Chemistry and Soils received several samples of dust in the recent fall of "brown" snow (February 24, 1936) from observers in New Hampshire and Vermont. A sample from Wells River, Vermont, was large enough to permit a mechanical analysis and chemical analysis of the dust of colloidal dimensions. This sample was largely silt and much coarser than the smaller samples obtained from Keene and Peterboro, New Hampshire. The colloidal matter from the Wells River sample yielded the following analysis:

SiO_2	48.9	per cent.
Al_2O_3	20.4	" "
Fe_2O_3	6.1	" "
CaO	5.4	" "
MgO	3.2	" "
Ignition loss	16.0	" "

It has been repeatedly shown that the ratio of silica to alumina plus iron oxide is a characteristic feature of the composition of the soil colloids of the great groups. This ratio varies from somewhat above 4 in the western soil colloids to less than 1 in the lateritic soils of the south. It is therefore useful in determining the origin of the material in dust storms. The analysis shows a ratio of 3.3 and also a relatively high content of lime and magnesia. All the samples showed the

presence of calcium carbonate and silicified organic remains, both characteristic of soils from the general region west of the Missouri. These characteristics taken together make it probable that this dust could not have originated east of the Mississippi River.

The fall at St. Johnsbury, Vermont, was estimated by observers at ten tons to the square mile. At Keene and Peterboro, New Hampshire, it was considerably less and the dust particles were much finer. The Peterboro sample showed an ignition loss of 15 per cent., which probably means that it is largely colloidal. This deduction is also indicated by microscopic examination. It would appear that there was considerable air elutriation or mechanical separation by air currents during the passage of the dust cloud toward the northeast.

The silt of the Wells River sample apparently contained as much or more lime than the colloidal matter. A fall of ten tons to the square mile amounts to 1,080 pounds of lime for that area. It can thus be seen that the quantity of plant food elements transferred long distances by dust storms may be considerable.

W. O. ROBINSON

BUREAU OF CHEMISTRY AND SOILS
U. S. DEPARTMENT OF AGRICULTURE

OCEAN SUNFISH IN HABANA WATERS

DURING the night of March 24, 1936, a large pointed-tailed sunfish (*Masturus lanceolatus*) was captured in Habana. It had entered the Almendares River a distance of 200 yards and was in a deep pool from which it could not escape when discovered. It was harpooned and gaffed and after a struggle of three hours was finally landed. The carcass was placed on exhibition, where it remained four days. Before being removed and disposed of it was opened and dismembered. There were no ossified bones in the skeleton. The substance of the skull and the spinal column resembled a hard stiff jelly or the meat of a ripe coconut. The rib, fin and tail bones were cartilaginous. The intestines were empty, except for a single fragment of seaweed and a small amount of dark fluid resembling thin mud. Both the intestines and the surface of the liver were infested with parasites. The same observation was recorded by Howell. A sucker-fish was found in the rear part of the buccal cavity. The fishermen are familiar with the sucker-fish that attach themselves to the surface of other fish, and they stated that the one found in the sunfish was different from any they knew.

The animal was 8 feet 6 inches long, 4 feet 3 inches deep in front of the dorsal fin and 8 feet 3 inches high through the dorsal and ventral fins. The dorsal fin was 2 feet 10 inches long and the ventral fin 2 feet 4 inches. The weight was estimated to be 1,200 pounds.

This is the second reported occurrence of the pointed-tailed sunfish in Habana waters. The other was reported by Howell[1] in 1934.

R. H. PALMER

HABANA, CUBA

SPONGE CONSERVATION

ON a recent visit to Tarpon Springs, Florida, I had an opportunity to see the sponging industry in that place, which is the largest of its kind in the world. Here is a sponge exchange to which are brought the catches for auctioning to the sponge buyers. I listened to the owner of the exchange addressing our group on sponging methods and was particularly impressed with his statements about the age of the industry, which he claimed had prospered in his native land, Greece, for more than two thousand years. I was still more impressed with the little change that had taken place in the sponging industry through these centuries. The only improvement that seems to have been made is in the use of gear to enable one to obtain from the deeper reaches of the sea the harvest that he seeks.

The wastefulness of the methods used to-day is the same as that in the ages gone by, and in this time of conservation it has occurred to me that scientific methods should be employed in the gathering of sponges.

Sponge culture, such as was carried on on Chase's Key in Florida prior to the war, showed that cuttings of sheepswool sponges an inch in size would grow to marketable size in from two to four years, depending on the species in question, and that method was there employed for cultivating or, let us say, growing sponges under controlled conditions.

To-day spongers merely rip the animals from their moorings, then haul them out on the beach to die, returning them to the sea long enough to macerate them and until the minute marine organisms clear away the flesh, leaving the spongy fiber, which is then carried to the so-called market or sponge factory, where the base with its attached bit of hard bottom is trimmed away and cast out, and the rest packed for further treatment. In other words, every time a sponge is ripped up the entire colony is destroyed.

The suggestion that I wish to offer is that the laws of the governments interested in sponge industry should be modified to require the spongers to cut the sponge from its mooring, leaving a small portion of the animal intact, or, if hauled aboard, to cut off the base and cast this back into the sea. By so doing, the animal will be able to regenerate the lost parts in due time. The gathering of the sheepswool sponge would then be comparable to the shearing of a sheep instead of killing and fleecing it, as is done at present. By this method a continued crop would be assured.

PAUL BARTSCH

U. S. NATIONAL MUSEUM

[1] Howell, *Mem. Soc. Cub. Hist. Nat.*, Vol. 8, p. 338, 1934.

SCIENTIFIC BOOKS

COPPER RESOURCES

Copper Resources of the World, Vols. I and II. 855 pages, 140 figures and 41 plates, 26.6×18.4 cm. XVI International Geological Congress, Washington, D. C., 1935. Price, $10.00.

FROM time to time the International Geological Congress publishes a comprehensive review of the resources of the world with respect to some mineral product of extreme economic importance. The contribution of its Washington meeting deals with copper. The committee in charge of the volume on copper states that "although this volume is primarily concerned with the geological environment of the known copper resources of the world, it has been thought that a clearer picture of these resources in their economic bearing could be presented by including a brief history of the development of the industry throughout the world, a discussion of the financial and economic factors of the industry, and an estimate of the amount of known reserves, with their geographical distribution." In addition there is included a brief description of some of the mining methods employed in the production of copper ores in North America, "as giving a picture of the current practice of a large and representative part of the copper industry."

The committee has succeeded, with the aid of many collaborators, in giving us a comprehensive and informational report on the world's copper resources and a prophecy as to the trend of the copper industry in the future.

Since 1840 the United States has produced 23,000,000 tons of the metal, or 55 per cent. of the world's production, but within the past decade, because of the discovery of large deposits of copper ores in the Belgian Congo and in Northern Rhodesia and the cheapness with which Canadian operators can separate copper from the gold ores of the Noranda area in Quebec and from the nickel ores in the Sudbury area in Ontario, this high percentage bids fair to be reduced markedly in the future.

Volume I deals with the deposits in North America and Volume II with those in South America, Europe, Asia, Africa and Australia. The total known reserves of the world's principal copper-producing companies has been estimated to be 3,536,242,832 tons of ore, with an average grade of 2.09 of copper, aggregating 73,934,300 tons of the metal, or enough to last about 70 years, provided the rate of production is that of the year 1929, which was about 1,185,780 tons. The four major known sources of supply are: (1) the Rocky Mountain and Great Basin area of the United States; (2) the west slope of the Andes in Peru and Chile; (3) the central plateau of Africa in the Belgian Congo and Northern Rhodesia, and (4) the pre-Cambrian shield area of central Canada and northern Michigan. These areas contain about 95 per cent. of the total known reserves. There are several areas of known copper ores in which the reserves have not been estimated and others in which the estimates have been increased, since the figures above quoted were calculated. Including these, Notman concludes that the present known reserves of the world are of the order of 100,000,000 tons of copper, and the average rate of production since 1929 has been about 1,450,000 tons. Since 1800 the United States has absorbed about 20,000,000 tons of the metal and there is known to be as much more available in the ground or about 300 pounds per person.

In addition to the reserves indicated in the above figures Notman states that it should be realized "that most of the proved districts contain many more millions of tons of the metal in material too low in grade to have been profitable in the past, but ready at any time for extraction when costs can be reduced or demand has increased to a point beyond the ability of the cheaper sources of supply to satisfy the needs."

The major portion of the book is devoted to descriptions of the geology of the districts in which copper-ore deposits occur, and discussions of the composition and nature of these deposits and the reserves known to exist in them. Sixty-eight individual collaborators and five organizations contribute to the discussions, producing a summary covering the entire world except for a few isolated districts in which information is lacking or in which the quantity of copper-ore known to occur is so small "as to be negligible so far as they may contribute to the world's output of the metal." The areas to which the largest paginations are devoted are Canada, Arizona, Chile, Peru and Africa.

The illustrations are mainly geological maps and sections and plans of mines. In addition to these there are eight reproductions of photographs.

The committee responsible for the plan of the volume and its contents are to be congratulated upon the result of their efforts. The report is a worthy companion of the coal, iron and gold volumes published during the past few years.

W. S. BAYLEY

THE LIFE OF J. ARTHUR HARRIS

J. Arthur Harris, Botanist and Biometrician. Edited by ROSENDAHL, GORTNER and BURR. University of Minnesota Press. Undated.

HERE is a book which every young biologist should

read. It sketches the life of a man of lofty ideals who made a lasting impress, not only upon science, but upon scientists.

The book tells a remarkable story, starting with the lad who trudged several miles over the dusty road in summer to pry open a schoolhouse window to obtain a definition of a word, and ending with the man who was head of the department of botany in the University of Minnesota. Harris later traversed many other wearisome roads and always with a worthy purpose in mind. He was fortunate in having worked in the first quarter of the present century when biological studies in America had such a great expansion. The records of such investigations in this period of fantastic growth are extremely important and we must be forever grateful to his colleagues who have cooperated to give us this little volume.

From 1907 to 1924 Harris was resident investigator in botany at the Station for Experimental Evolution of the Carnegie Institution of Washington, Cold Spring Harbor. During these years he pursued studies in variation, adaptation and natural selection, devoting a large portion of his time to the development of methods for statistical analysis of biological data. He will ever be renowned for his assiduous devotion to the quantitative study of biological problems, as well as for several very important contributions to biometric theory and computational techniques. He was obsessed with the necessity of putting biology on a more exact basis. He advocated the importance of biometry at a time when most biologists regarded that subject with indifference, not to say hostility. That he lived to see the growing interest in the subject and its inclusion in university curricula is most fortunate. Shortly before his death he wrote the following words as a summary of his program: "For nearly thirty years I have not been particularly interested in any one specific biological problem. I have been interested in what I felt was the more important problem, *i.e.*, the problem of the method of solving biological problems." This biographical volume also contains five posthumous papers on biometry and biometrical subjects.

Harris is also well known for his extensive studies on the physico-chemical properties of plant sap in relation to taxonomic affinities, to geographic distribution and to various ecological factors. Many interesting accounts of these investigations are related in this volume. We learn from it that a great mass of his results unfortunately were never published.

The versatility of Harris is also shown by various writings here recorded. The volume contains his delightful satire on the regimentation of science entitled, "A Great Institute for the Study of the Psychology of the Mule" and "Desert Beef," a parody on Hiawatha. His poem "To Pahvant," a volcanic butte, is an expression of refined sentiment for the majesty that exists in nature.

This volume will richly repay the reading by any one who wishes to know something about one of the most engaging personalities who lived and worked in one of the important periods of the biological sciences. It will not only instruct but will inspire its readers.

H. S. REED

UNIVERSITY OF CALIFORNIA

SOCIETIES AND MEETINGS

THE WEST VIRGINIA ACADEMY OF SCIENCE

THE thirteenth annual meeting of the West Virginia Academy of Science was held on the campus of Bethany College at Bethany on May 1 and 2, 1936. About 170 members were in attendance.

A general business session was held on Friday morning, at the conclusion of which the academy was welcomed by President Cramblet of Bethany. The presidential address, "The Life History of a Bone," was then delivered by Professor G. S. Dodds, of West Virginia University.

At noon the academy lunched by sections. In the afternoon the academy met in sections to hear a total of 53 papers read. At the section meetings the following chairmen were elected for the coming year: *Biology,* Professor R. C. Patterson, Potomac State College; *Chemistry,* Professor J. B. Bartlett, Marshall College; *Geology and Mining,* Professor H. C. Martens, West Virginia University; *Mathematics and Physics,* Professor R. P. Hron, Marshall College; *Social Science,* Group I, Professor E. L. Lively, Fairmont State College; *Social Science,* Group II, Professor Roy Woods, Marshall College.

A dinner was held in the evening, after which the academy met to hear the principal address of the meeting delivered by Professor H. B. Lemon, of the University of Chicago. Professor Lemon's subject was "Some Aspects of the Mystery of Light." Following the address an informal reception and smoker was held at the home of President Cramblet.

The final business session of the meeting was held on Saturday morning, at which time the following officers were elected for the coming year: *President,* Professor Frank Cutright, Concord State College; *Vice-President,* Professor T. L. Harris, West Virginia University; *Secretary,* Professor M. L. Vest, Davis and

Elkins College; *Treasurer,* Professor C. G. Brouzas, West Virginia University; *Editor,* Professor A. M. Reese, West Virginia University.

Following the business session tours were made to some of the industrial plants of the region.

The West Virginia Junior Academy of Science held its meeting one week earlier at Charleston. The meeting was reported to be very successful. The 1937 meeting of the academy will be held on April 30 and May 1 at Marshall College, Huntington. The Junior Academy will hold its meeting at the same time and place.

M. L. VEST,
Secretary

THE NEW HAMPSHIRE ACADEMY OF SCIENCE

THE eighteenth annual meeting of the New Hampshire Academy of Science was held on May 29 and 30 at Shirley Hill House, Goffstown. The Friday evening session was devoted to papers by members and to a series of electrical demonstrations.

A symposium on "Conservation of New Hampshire's Natural Resources" was held on Saturday morning, under the chairmanship of Professor Karl W. Woodward. Representatives of the White Mountain National Forest, the Society for the Protection of New Hampshire Forests, Soil Conservation Service, Division of Chemistry and Sanitation of the State Board of Health, the State Water Resources Board and Fish and Game interests presented prepared papers, which were followed by vigorous discussion.

At the Saturday afternoon session, following the business meeting, the presidential address, "Popularizing Science," was given by Mr. Albert L. Clough, president of the Manchester Institute of Arts and Sciences. The remainder of the scientific papers on the program were then read.

At the business meeting it was announced that the American Association for the Advancement of Science grants had been recommended by the council to Professor Charles F. Brooks, of the Blue Hill Observatory, for analysis of certain meteorological data from the Mt. Washington Observatory, and to Mr. Richard P. Goldthwait, of Harvard University, for studies on the geology of Mt. Washington. The academy also voted Mr. Goldthwait a further grant from the academy funds to aid his work.

The following officers were elected for 1936-37: *President,* Professor George M. Robertson, Dartmouth College; *Vice-president,* Professor Karl W. Woodward, University of New Hampshire; *Secretary-Treasurer,* Professor George W. White, University of New Hampshire; *Member of the Executive Council,* Mr. Albert L. Clough, Manchester Institute of Arts and Sciences; *Councillor to the American Association for the Advancement of Science,* Professor Walter C. O'Kane, University of New Hampshire.

GEORGE W. WHITE,
Secretary

REPORTS

MICROWAVE RADIO CIRCUIT OF THE RADIO CORPORATION OF AMERICA

THE first demonstration of the Radio Corporation of America's ultra-short wave radio circuit connecting New York and Philadelphia was given on June 11. The two institutions which were first to recognize the importance of the electric telegraph of Samuel F. B. Morse a century ago celebrated this new advance in communications by exchanging greetings. In 1836 Professor Morse gave the first demonstration of his new instrument to his colleagues at New York University. He gave the next demonstration outside New York City before the membership of the Franklin Institute in Philadelphia. On June 11 Chancellor Harry Woodburn Chase, of New York University, and Vice-president W. Chattin Wetherill, of the Franklin Institute, Philadelphia, exchanged pictures and greetings by radio facsimile. Models of the first Morse apparatus were connected to the circuit and operated simultaneously with the facsimile equipment.

Chancellor Chase radioed:

It is eminently fitting that New York University, which cradled the theory and practice of electrical communications, and the Franklin Institute, the learned society which was the first outside of New York to appreciate their significance, should to-day join in recognizing this new and important centennial milestone in the translation of intelligence. I am happy to have this opportunity to send heartiest greetings to you and your organization over one of the channels of the new, ultra-high radio frequency circuit for facsimile transmission. This development is but another evidence of the great achievements which scientific effort is daily producing for the service of mankind.

Vice-president Wetherill responded:

The Franklin Institute is particularly gratified to acknowledge the greetings of New York University on this the first public demonstration of the new ultra-high frequency radio circuit. Since 1824 the Franklin Institute has devoted itself to the promotion of science and the mechanic arts. It is, therefore, especially appropriate for us to join with New York University in appreciation of this new and important development.

A century ago, the Committee on Science and the Arts of the Franklin Institute in reporting on its examination

of the electro magnetic telegraph invented by Professor Samuel F. B. Morse stated in part: "The committee beg to state their high gratification with the exhibition of Professor Morse's telegraph, and their hope that means may be given to him to subject it to the test of an actual experiment made between stations at a considerable distance from each other."

Since that distant day, scientific research and a public appreciation of its contribution to human progress have made possible this epoch-making event in which we are participating to-day.

We send to you and your colleagues our kindest personal regards.

In a statement to guests present at the New York end of the radio circuit, David Sarnoff, president of the Radio Corporation of America, said:

Radio communication is to-day placing in useful public service a region of the radio spectrum which only yesterday was virtually unexplored and scientifically unconquered territory. Having developed a technique of operation for the three-meter band of radio wave-lengths, we find in that region a medium of transmission unlike anything that we have ever known.

The most significant feature of the new communications development is that it marks the attainment of a radio circuit so efficient that we are challenged to take full advantage of it. This is very important, for radio communication has, from its beginning, struggled to provide even better connecting radio channels between transmitter and receiver. Now we find that the ultra-short-wave portion of the radio spectrum gives us a medium of almost unbelievable possibilities. We can not only send messages in facsimile as fast as present equipment will allow, but we can send two pictures simultaneously, and on the same radio wave we can also add two automatic typewriter channels and a telegraph channel. Of course, this means that we do all those things in both directions at the same time.

The possibilities of multiple transmission are still not exhausted. Perhaps this single illustration will give some idea of the traffic-handling possibilities of the circuit. If we were concerned only with communication on a word basis, we could, with increased power and filter systems, operate enough automatic typewriters to carry a total of twelve thousand words per minute in both directions between New York and Philadelphia.

Such flexibility, in being able to accommodate so many separate services simultaneously offers important commercial advantages. But we intend to continue this development further with the object of creating new devices for higher speeds of transmission on the individual channel. There would be little point in our using the new system merely to add another hundred or two automatic typewriter channels between these two cities when adequate wire facilities for such services already exist. We can not be content merely to duplicate present practice at this stage of radio's development. Now that we have the circuit, we shall turn again to the laboratory to find out how best to make use of it. Of course radio wants its share of telegraphic traffic, but it looks also at the much bulkier mail bags.

According to a statement from the Radio Corporation, the equipment developed for the new circuit is regarded in engineering circles as a great advance. The automatic repeater stations, which catch the micro-waves flying in both directions and fling them on to their destinations at New York and Philadelphia, are located at New Brunswick, New Jersey, and Arney's Mount, near Trenton, New Jersey. Since the range of three-meter radio waves is virtually limited to line-of-sight, the points of reception and transmission for each of the stations were selected to provide the most distant optical horizon. In New York and Philadelphia, therefore, the antennas are located atop tall office buildings, whereas the intermediate points of New Brunswick and Arney's Mount were chosen for their favorable terrain.

Each of the repeater stations employs two different transmitting wave-lengths, or one for each direction. The two terminal stations each use one sending wave, making a total of six wave-lengths, or frequencies, for the complete circuit. If it should be desired to extend the circuit beyond either terminal point, those six microwaves could be used over and over again in the same sequence. Thus, two waves of the same length would be generated at points about one hundred miles apart, and would not interfere with each other, because of the line-of-sight limitation to their range.

A feature of the new circuit is the method by which the unattended relay stations may be turned on or off from either one of the terminal stations by radio. The receivers at each of the four stations are always alive and ready to catch impulses from their assigned transmitters. When it is desired to make the circuit ready for traffic, New York or Philadelphia starts up its transmitter and sends a certain musical note which the receiving circuits are pre-set to "recognize." At the unattended receiver at New Brunswick the tone passes through electrical filters somewhat like a key passed through the tumblers of a lock. Electrical circuits "accept" the tone and relays are actuated, turning on the power for the "south" transmitter, which, when in operation, passes the tone on by radio to the Arney's Mount station. There the operation is repeated.

When the tone signal reaches the Philadelphia station, the transmitter at that city is also automatically turned on, and the tone starts on its return journey, back to New York. Operators in New York know that when the tone comes back to them from the "north" transmitter at New Brunswick the entire circuit is in full operation and ready for traffic. The constant presence of the tone keeps the relays closed, and the

circuit in an operating condition. When the tone is withdrawn from the circuit, relays click in the same succession over the round trip to Philadelphia, and one by one the transmitters are automatically turned off. Philadelphia has the same control over the circuit as New York.

The new circuit is described by officials of the Radio Corporation of America as an example of the value of coordinated research and engineering in many special phases of radio. There being no precedent for building apparatus for commercial operation on three meters, the equipment developed is new. Antennas, because of their curious form, are characterized as "Christmas trees" and "turnstiles." Certain parts of the receivers look like small steam engines and the transmitters might be taken for hot-water boilers. These odd shapes result from the application of the principle of "resonant lines" to both transmitters and receivers. That principle, developed by the Radio Corporation of America for this use, eliminates crystal control and provides economical and efficient means of maintaining radio equipment in steady tune at extremely short wave-lengths.

The heart of the receiver is the "shoe button" or "acorn" tube, so-called because of its minute dimensions, and in the transmitters there are new power tubes specially designed for microwave service. These special tubes, along with the antenna, transmitter, receiver, facsimile and terminal-control apparatus, were all developed in a group of Radio Corporation of America laboratories, each specializing in a separate phase of the work.

SPECIAL ARTICLES

THE SIZE OF ANTIBODIES

RECENT work has demonstrated that at least some of the antibodies in the blood of immunized animals are proteins or are intimately associated with proteins. Thus arises the question of the relation between these bodies and proteins found in the blood sera of normal animals. The ultracentrifugal analysis initiated by Svedberg[1] offers a way of investigating this problem. To make such an analysis a small quantity of solution is centrifuged at very high rotational speeds. In the intense gravitational fields thus produced big solute molecules will be thrown down just as are precipitates in an ordinary centrifuge. The rate at which the different molecular species are sedimenting can be recorded by photographing through the solution. This rate of sedimentation is commonly expressed as a sedimentation constant s. Though not directly a measure of weight, since it also depends on such factors as the molecular shape, s increases with the molecular weight.

Mutzenbecher[2] and later McFarlane,[3] both working in Svedberg's laboratory, have subjected many sera to this analysis. The normal sera of several kinds of animals show an albumen with a sedimentation constant $s = ca\ 4 \times 10^{-13}$ cm sec^{-1} $dynes^{-1}$, a principal globulin with $s = ca\ 7 \times 10^{-13}$ and small amounts of heavier globulins. Equilibrium studies have proved that this albumen has a molecular weight of ca 69,000 and that the globulin with $s = 7 \times 10^{-13}$ has a probable weight of ca 138,000.

We have applied the same method of analysis to several concentrated antibody preparations to see how the sedimentation constants of their proteins compare with those of normal sera. The apparatus used, which is a development of the air-driven turbine,[4] is described in a forthcoming number of the *Journal of Experimental Medicine*.

Among the most thoroughly studied antibodies are those in antipneumococcic horse serum. The work of Felton[5] and others has made possible commercial preparations containing these antibodies in concentrated form. We have made ultracentrifugal analyses of the ultra-violet absorbing material in such concentrates[6] of Types, I, II and VIII antibodies. Recent ultrafiltration experiments[7] on old but untreated Type I antipneumococcic horse serum have shown that its antibodies have a particle size between 54mμ and 140mμ. This means either that these antibodies have exceptionally large molecular weights or that as the serum aged they became or attached themselves to larger colloidal particles. All antibody concentrates have accordingly been examined to find out whether they contained appreciable quantities of such large molecules.

The chief component capable of absorbing light of wave-lengths λ2400–λ2700 in each Felton antibody preparation has a sedimentation constant of ca 15×10^{-13}. Besides the principal globulin with $s = 7 \times 10^{-13}$, normal horse serum[8] contains a small amount of another globulin with $s = ca\ 19 \times 10^{-13}$ and

[1] T. Svedberg, *Naturwiss.*, 22: 225, 1934, for bibliography.

[2] P. Mutzenbecher, *Biochem. Zeits.*, 235: 425, 1931; 266: 226, 250, 259, 1933.

[3] A. P. McFarlane, *Biochem. Jour.*, 29: 407, 660, 1175, 1209, 1935.

[4] J. W. Beams and E. G. Pickels, *Rev. Sci. Instruments*, 6: 299, 1935.

[5] L. D. Felton, SCIENCE, 79: 277, 1934; *Jour. Immunol.*, 27: 379, 1934; etc.

[6] All ultracentrifuged preparations have been manufactured by the Lederle Laboratories, Inc.

[7] W. J. Elford, P. Grabar and W. Fischer, *Biochem. Jour.*, 30: 92, 1936.

[8] P. Mutzenbecher, *op. cit.*

occasionally an intermediate globulin with $s = 9 \times 10^{-13}$. Whether the Felton globulin with $s = ca\ 15 \times 10^{-13}$ represents an alteration or an association product involving one of these normal globulins or is a totally new protein can not of course be told from the present experiments. No molecular species sedimenting faster, and thus having a larger weight than the Felton globulin, could be found in any preparation. These experiments demonstrate that the globulins present in Types I, II and VIII concentrates have approximately the same sedimentation constants. Some samples, however, contained antibodies against more than one type so that additional experiments with monovalent preparations are being carried out to ascertain whether small differences characteristic of type can be detected.

All the Felton antibody concentrates also contained a considerable quantity of ultra-violet absorbing material sedimenting more slowly than the lightest protein molecules in normal horse serum. This "uncentrifugable" material, which very possibly consists of split products introduced by the concentrating procedures accounts for about 30 per cent. of the total ultra-violet light absorption.

Normal horse serum treated by the Felton procedure gives only a very small globulin yield. This yield is, however, materially increased if the final precipitation is made after a slightly more alkaline pH adjustment. When ultracentrifuged, such normal globulin concentrate is found to contain two components, one with $s = 17 \times 10^{-13}$; the other with $s = 9 \times 10^{-13}$. It is quite possible that these are to be identified with the two heavier globulins found by Mutzenbecher.

We have also examined a purified antibody[9] obtained from a rabbit immunized against one of the azoproteins of Landsteiner and van der Scheer.[10] The sedimentation pattern of this material, which was supplied by Dr. K. Landsteiner, shows but one molecular species. Its sedimentation constant, 7×10^{-13}, does not differ from that of the lightest and principal globulin in normal sera.

CONCLUSION

The sedimentation constants from the ultracentrifugal analysis of several concentrated antibody preparations are of the same order of magnitude as those of the globulins of normal sera. If these antibodies are proteins or are associated with proteins and if concentration has proceeded till such proteins are a major constituent of these preparations, then it follows that antibody properties are not necessarily associated with exceptionally large molecular size. A more detailed account of these and related experiments will be published later.

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[9] This antibody was made by a modification of the method described in K. Landsteiner and J. van der Scheer, *Jour. Exp. Med.*, 63: 325, 1936.

[10] See K. Landsteiner, "The Specificity of Serological Reactions" (Thomas, Springfield, 1936).

THE ORGANISMS OF CHROMOMYCOSIS OF NORTH AND SOUTH AMERICA[1]

THE organisms responsible for the disease known as chromomycosis (chromoblastomycosis) or dermatitis verrucosa are perhaps as confusing to the clinician and mycologist as the fungi producing the infectious condition known as blastomycosis. Heretofore, the exponents of the microbes of this malady have classed only two organisms as causative agents. One, *Phialophora verrucosa,* was described for the first time in the United States by Thaxter from a case of Medlar, and the other, the much disputed *Acrotheca Pedrosoi,* was described in South America (Brazil) perhaps for the first time by Pedroso in 1911.

The organism of North American chromomycosis has withstood any change in nomenclature, and since its first description in 1915 has been isolated from a second case in the United States in 1933 and reported by Wilson, Hulsey and Weidman from Texas. In the same year (1933), the same fungus was isolated from the disease in Montevideo, Uruguay, by MacKinnon. *Acrotheca Pedrosoi,* on the other hand, was first named *Hormodendrum Pedrosoi* by Brumpt in 1921. In the following year, Terra Torres, Fonseca and Leão found conidiophores suggestive of *Acrotheca* and changed the name. In 1929, Langeron in France studying the culture obtained by Brumpt from Brazil found on liquid media indications that suggested characteristics of *Trichosporium,* and the name was again changed to *T. Pedrosoi.* Since then, the three names have been used interchangeably for the same microbe, with *Acrotheca* perhaps dominating. Weidman in his publication suggested that perhaps these two organisms were different form genera of one and the same species, which in the light of present observations is quite possible.

Unfortunately, from a mycological, nomenclatorial point of view, a good comparative, cultural study of the fungi of North and South America had never been made. While in São Paulo, Brazil, the opportunity presented itself to make such a study, with Floriano de Almeida, of the organism of Thaxter and several from South America, including Brazil, Uruguay and Argentina. Several interesting facts arose as a result.

[1] A study made by the author while in Sao Paulo, Brazil, as a John Simon Guggenheim Memorial Foundation fellow.

In the first place, it was found that *Phialophora* is not limited to North America, as MacKinnon was able to point out in Uruguay. One of the original cultures of Pedroso and Gomes, described as *Acrotheca* by Fonseca, we found to be *Phialophora*. A fungus recently described from Buenos Aires presents characteristics which are clearly those of *Phialophora*. In the second place, a careful examination of fungi described as *Acrotheca* revealed properties, such as branching, successive conidiophores and conidia in head formation, which are definitely not those of the genus, but more related to the large heterogeneous *Botrytis*. Due to additional characteristics which are those of the Dematiaceae and not of the Mucedinaceae, a new genus is proposed, namely, *Botrytoides* Moore and Almeida, to replace *Acrotheca* and *Trichosporium* for the causative organism of chromomycosis. Thirdly, the genus *Hormodendrum* has been isolated from authentic cases of this disease. Finally, a microbe isolated from a recent case in São Paulo has characteristics common to all the above-named genera.

When first grown, the new fungus appears much like *Trichosporium* as described by Langeron, a characteristic which, if interpreted correctly, however, is not consistent with that genus. When examined carefully on several media, the conidiophore of *Botrytoides* is clearly visible, and further, the type of spore formation of *Hormodendrum* is discernible. On several media, particularly Czapek's, in addition to these facts, the cup formation of conidia production is quite marked, appearing on approximately the twelfth day. This is distinctly a property of *Phialophora*. On Sabouraud's maltose agar the cup formation is seen almost exclusively, while on still other media, no cups, but branching conidia or conidiophores similar to those of the genus *Acrotheca* are found. For this complicated new organism, which apparently suggests itself as a missing link that binds *Botrytoides*, *Phialophora* and *Hormodendrum* in close relationship, the name *Phialoconidiophora Guggenheimia* Moore and Almeida, new genus and new species, is given. The species is gratefully dedicated to the John Simon Guggenheim Memorial Foundation for making this study possible.

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DIFFERENTIAL SUSCEPTIBILITY OF LIVING ORGANISMS TO SUPERSONIC VIBRATIONS

GRADED differentials in susceptibility to a large number of physical and chemical agents, not differing specifically with different agents, are very generally characteristic of the polar axes of animals at least during the earlier stages of development and in some of the simpler forms throughout life. A respiratory gradient and a gradient in rate of reduction of vital dyes as well as various other differentials have been found to parallel closely the susceptibility gradient in animals from which data have been obtained. In view of these facts, it is of interest to determine whether a differential susceptibility to supersonic waves, a primarily mechanical factor, exists.

In the experiments described below a modified Hartley oscillator circuit employing a 100-watt tube operated by raw alternating current was used to drive a large quartz crystal at its natural frequency of 612 kilocycles per second. The crystal was mounted between two heavy brass electrodes and served as a microscopic slide on the insulated stage of a grounded microscope. The lower electrode had a circular opening to permit a beam of light to pass through. The upper grounded electrode, when placed on the crystal, formed the wall of a cavity or cell for holding the experimental animals in water. The arrangement was held in place by a wooden frame soaked in paraffin. The intensity of the supersonic field was changed by modifying the input of the oscillator. A radio frequency milliammeter was used to give a rough measure of intensity.[1]

The temperature of water in the electrode cell rose approximately 6° C. during the average exposure required, but this rise was decreased to approximately 2° by introduction of a glass capillary tube cooling system. This rise in temperature during the few minutes of exposure which was required to observe the visible changes was not a factor in results. Control experiments with a similar rise in temperature and a period of exposure three times the usual experimental exposure showed no effects of temperature.

When *Euplanaria dorotocephala* is exposed to supersonic vibration the posterior tip and margins of the posterior zooid or zooids show disintegration first, and as the posterior zooid region disintegrates, disintegration begins in the head region by the cytolysis of the lateral margins and the auricles. Next the ganglionic region disintegrates, leaving the optic pigment visible for some time in the disintegrated mass of the head. Intact parts show strong muscular stimulation and profuse mucus secretion. Intense stimulation of the pharynx causes it to be extruded through the dorsal body wall and complete separation occurs, as with irritating chemical agents. The pharynx does not disintegrate, because it is thrown about the field by the wave patterns, and probably is not subjected to definite waves in one position long enough to show any effects.

The time required for disintegration varies with the intensity of the supersonic field and the condition of

[1] The cooperation of Dr. J. Barton Hoag, of the department of physics, University of Chicago, in construction of the apparatus is gratefully acknowledged.

the animal. With medium intensity the first signs of cytolysis appear in one minute and in three to four minutes disintegration is far advanced. Disintegration ceases after cessation of the vibration, intact parts remain alive and may reconstitute whole animals.

Tubifex tubifex, subjected to supersonic vibration, is very active showing intense stimulation. High intensity results in almost instantaneous death and disintegration, but with lower intensity the posterior growing segments disintegrate first, and disintegration progresses anteriorly. Simultaneously, a short gradient appears in the anterior region of the body.

Observations on hydra show that the tentacles disintegrate basipetally, but the body contracts so strongly that it is difficult to determine the course of disintegration there.

These supersonic disintegration gradients are the same as those observed with other agents and, so far as data are available, the same as the respiratory gradients and gradients in reduction of vital dyes. Evidence of alteration of reconstitution and of head frequency in *Euplanaria* by supersonics has already been obtained and work is being continued.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

ARTIFICIAL MEDIA FOR THE CULTIVATION OF FIBROBLASTS, EPITHELIAL CELLS AND MONOCYTES

THE object of the present communication is to describe two synthetic media that have been developed for the cultivation of cells outside the body. One was designed to promote the rapid proliferation of fibroblasts and epithelial cells; the other, that of monocytes. These media contain practically the same ingredients; they differ in the concentration of these ingredients.

Two synthetic media for fibroblasts, less complete than the one to be described here, have already been devised. The first of these contained a peptic digest of casein, glycocoll, nucleic acid, glutathione, hemoglobin, glucose and some ash of liver. A pure strain of fibroblasts from Crocker 10 sarcoma proliferated in this medium for 40 days as rapidly as did control tissues that were cultivated in embryo juice.[1] This medium did not suffice, however, for the cultivation of normal fibroblasts. The second medium, one devised by Vogelaar and Erlichman,[2] has given better results with the normal cells. It contained Witte's peptone, hemin, cysteine, insulin, thyroxine, glucose and the usual salts. Fibroblasts emanating from human thyroid tissue that was embedded in irradiated cow plasma proliferated in this medium for three months. The medium failed, however, to nourish chicken heart fibroblasts that were embedded in coagula made of horse plasma.[3]

The new medium to be described here contains all the substances used by Vogelaar and Erlichman, and in addition a number of others that greatly enhance its power to promote growth and maintain cell life. Its composition is as follows:

	Per 100 cc	
Witte's peptone	675.00	mg
Cysteine hydrochloride	9.00	"
Hemin	0.0036	"
Insulin	0.09	units
Thyroxine	0.0009	mg
Glucose	100.00	"
Serum homologous to the tissue	10.00	cc
Vitamin A[4]	900.00 to 1800.00	units
Vitamin D[4]	about 15.00 to 30.00	"
Vitamin C (crystalline ascorbic acid)	0.25	mg
Glutathione	1.00	"
Phenol red	5.00	"
Sodium chloride	720.00	"
Potassium chloride	18.00	"
Calcium chloride, anhydrous	18.00	"
Magnesium chloride, 6 H_2O	9.00	"
Sodium dihydrogen phosphate	4.50	"
Sodium bicarbonate, anhydrous	100.00	"

When the solution is used for the cultivation of organs, the glucose is increased to 300 mg per cent., and the sodium chloride reduced sufficiently to keep the solution isotonic. A small amount of iodine is added when the medium is used for the cultivation of the thyroid gland.

This new medium promotes more rapid and more prolonged growth of fibroblasts than does any artificial medium previously devised. Chicken heart fibroblasts that were embedded in horse plasma proliferated in this medium two or three times as rapidly as did control tissues that were cultivated in the feeding solution of Vogelaar and Erlichman. A pure strain of these cells multiplied actively for six weeks without showing any deterioration or decrease in growth rate. Control fibroblasts, cultivated under the same conditions in the Vogelaar feeding solution, underwent fatty degeneration and died in 12 or 14 days. The new medium causes fibroblasts to proliferate for a time fully as rapidly as they do in embryo juice. In one experiment, two tiny fragments of heart fibroblast that were in their sixth passage *in vitro* increased in size so fast that they completely covered the coagulum in a D-3 flask in 11 days. This rapid growth does not continue indefinitely, of course, for the medium is still incomplete.

[1] L. E. Baker, *Jour. Exp. Med.*, 49: 163, 1929.
[2] J. R. M. Vogelaar and E. Erlichman, *Am. Jour. Cancer*, 18: 28, 1933.
[3] Unpublished experiments of the author's.
[4] Vitamins A and D were supplied together by using a concentrate prepared from halibut liver oil.

In addition to promoting proliferation of fibroblasts, this medium causes growth of muscle cells and epithelial cells. Fragments of fresh heart produced a considerable mass of actively pulsating tissue when they were cultivated in this medium. Iris epithelium from a chick embryo proliferated in the medium for 65 days.

When the medium was used in the Lindbergh[5] apparatus for the cultivation of whole adult organs,[6] the following interesting results were obtained. Ovaries of the adult cat tripled their weight in 5 days. Thyroids doubled their weight in 3 or 4 days. The epithelial cells proliferated within and also outside the follicles. The follicles also increased in number to a marked extent. The glucose consumption of the organs was considerably greater than that of organs cultivated in 40 per cent. serum. Thus, cat thyroids cultivated in the artificial medium metabolized 17 mg of glucose daily, whereas those cultivated in serum metabolized only 7 mg daily. After the thyroids had been cultivated for some time in this medium, they were sectioned, and fragments from them were cultivated according to the usual techniques. These fragments grew as actively as do fragments of embryonic thyroid.

The medium designed for the cultivation of monocytes has the following composition:

	For cells cultivated in a fluid medium per 100 cc		*For cells cultivated in a coagulum per 100 cc*	
Serum	25.00	cc	25.00	cc
Witte's peptone*	85.00	mg	170.00	mg
Vitamin A[4] ..50.00 to	100.00	units	100.00 to 200.000	units
Vitamin D[4] .. 1.00 to	2.00	"	2.00 to 4.00	"
Vitamin B_1[7] ...	0.0053	"	0.0106	"
Vitamin B_2[7] ...	0.0001	"	0.0002	"
Vitamin C (crystalline ascorbic acid) ...	0.085	mg	0.17	mg
Glutathione ...	0.34	"	0.68	"
Cysteine hydrochloride	1.125	"	2.25	"
Hemin	0.00045	"	0.0009	"
Insulin	0.012	units	0.024	units
Thyroxine	0.000113	mg	0.000225	mg
Phenol red	5.00	"	5.00	"
Glucose	200.00	"	200.00	"
Sodium chloride	581.00	"	581.00	"
Potassium chloride	15.00	"	15.00	"
Calcium chloride, anhydrous ..	15.00	"	15.00	"
Magnesium chloride, 6 H_2O..	7.50	"	7.50	"
Sodium dihydrogen phosphate	3.75	"	3.75	"
Sodium bicarbonate	75.00	"	75.00	"

* Monocytes proliferate more rapidly in tryptic digests of fibrin than they do in Witte's peptone.[8] Such digests may be substituted for the peptone. The peptone has been used here because of the greater ease with which the medium can be reproduced.

[5] C. A. Lindbergh, *Jour. Exp. Med.*, 62: 409, 1935.

[6] A. Carrel and C. A. Lindbergh, SCIENCE, 81: 621, 1935.

[7] Obtained from a concentrate prepared by Burroughs Wellcome and Company.

[8] L. E. Baker, *Jour. Exp. Med.*, 57: 689, 1933.

When the medium is used for organ cultivation, the glucose is increased to 300 mg per cent., and the sodium chloride reduced sufficiently to keep the solution isotonic.

Chicken monocytes have been cultivated in this medium for 80 days. At first, they proliferated so actively as to cover the entire area of the flask in four days. Half of the cells were then removed. In another three days, the flask was again covered with cells. In order to prevent overcrowding, a portion of the cells was removed every four or five days for at least a month. After that, proliferation was not so rapid. It continued, however, throughout the entire 80 days of cultivation. Control cells that were cultivated in 25 per cent. serum without any of the other constituents of the medium proliferated very slowly. It was not necessary to remove any cells to prevent overcrowding during their entire time of cultivation.[9]

The quantity of serum used in the medium may be varied to a considerable extent, according to the results desired. When it is increased to 50 per cent. proliferation is still more rapid. When it is reduced to 15 or to 10 per cent., the cells proliferate less rapidly. It can not be eliminated altogether. With as low a concentration as 10 per cent. serum, the medium sustained the proliferation of monocytes for 62 days. Control cells cultivated in 10 per cent. serum and Tyrode solution, without the other ingredients of the medium, died in 12 days. It is evident, therefore, that the constituents used with the serum have a true nutritive value, and can replace serum to a considerable extent. This medium is now being used with success for the cultivation of whole adult spleens in the Lindbergh apparatus.

To summarize: Artificial media have been developed that cause fibroblasts, epithelial cells and monocytes to proliferate rapidly. Although still incomplete, and needing serum as one constituent, they allow the cultivation of cells for considerable periods of time. For the present, they are the most efficient artificial media as yet devised for the cultivation of tissues and entire organs.

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[9] The controls were kept for only a month.

BOOKS RECEIVED

CLARK, J. G. D. *The Mesolithic Settlement of Northern Europe; A Study of the Food-Gathering Peoples of Northern Europe during the Early Post-Glacial Period.* Pp. xvi + 284. 74 figures. 8 plates. Cambridge University Press, Macmillan. $9.00.

HULL, GORDON F. *An Elementary Survey of Modern Physics.* Pp. xxiv + 457. Illustrated. Macmillan. $4.50.

PENNELL, VERNON. *A Handbook of Urology for Students and Practitioners.* Pp. viii + 224. 34 figures. Cambridge University Press, Macmillan. $2.75.